

WHAT IS CLAIMED IS:

1. A position and orientation determination apparatus which identifies a parameter indicating a position and orientation of capture means for capturing a picture in real  
5 a space containing a plurality of feature points whose positions are known in a three-dimensional array, comprising:

position and orientation measurement means for measuring the position and orientation of the capture means  
10 in a method other than using a captured picture;

detection means for detecting the plurality of feature points and their positions in a two-dimensional array on an image pickup screen using the picture in the real space captured by said capture means;

15 prediction means for predicting the positions of the feature points in the two-dimensional array on the image pickup screen based on the position and orientation of said capture means measured by said position and orientation measurement means; and

20 correction means for correcting the parameter indicating the position and orientation of said capture means based on the positions of the feature points on the image pickup screen of said capture means obtained by said prediction means, and based on the positions of the feature  
25 points obtained by said detection means,

wherein said parameter indicating the position and orientation of said capture means for capturing the real

space is identified by said correction means correcting the parameter.

2. The position and orientation determination apparatus  
5 according to claim 1, wherein an artificially applied marker is used as the plurality of feature points whose three-dimensional positions are known.

3. The position and orientation determination apparatus  
10 according to claim 1, wherein a point originally existing in the real space as the plurality of feature points whose three-dimensional positions are known, and whose two-dimensional positions can be detected on the image pickup screen by said detection means.

15 4. The position and orientation determination apparatus according to claim 1, wherein on the picture in the real space captured by said capture means, another image is superimposed and displayed.

20 5. The position and orientation determination apparatus according to claim 4, wherein said another image is a drawn image of a virtual object.

25 6. The position and orientation determination apparatus according to claim 1, wherein said position and orientation

measurement means is a sensor for measuring the position and orientation of said capture means.

7. The position and orientation determination apparatus  
5 according to claim 6, wherein said sensor is a magnetic sensor for measuring the three-dimensional position and orientation of said capture means.

8. The position and orientation determination apparatus  
10 according to claim 1, wherein said correction means corrects the parameter such that said capture means either rotates or translates.

9. The position and orientation determination apparatus  
15 according to claim 1, wherein said correction means corrects the parameter of said capture means by combining rotation transform with translation transform.

10. The position and orientation determination apparatus  
20 according to claim 9, wherein said correction means corrects the parameter of said capture means by combining rotation transform with translation transform alternately and plural times.

25 11. The position and orientation determination apparatus according to claim 9, wherein said correction means corrects the parameter such that said capture means can

rotate, and then re-predicts the two-dimensional position  
of the feature point on the image pickup screen based on  
the position of the feature point in the real space and the  
position and orientation of the camera after the correction,  
5 and said capture means can translate.

12. The position and orientation determination apparatus  
according to claim 9, wherein said correction means  
corrects the parameter such that said capture means can  
10 translate, and then re-predicts the two-dimensional  
position of the feature point on the image pickup screen  
based on the position of the feature point in the real space  
and the position and orientation of the camera after the  
correction, and said capture means can rotate.

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13. The position and orientation determination apparatus  
according to claim 1, wherein said correction means  
computes a first average value on the image pickup screen  
of said capture means using the position of the feature  
20 point obtained by said prediction means, and a second  
average value on the image pickup screen of said capture  
means of the feature point detected by said detection means,  
and corrects the parameter such that the first average value  
matches the second average value.

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14. The position and orientation determination apparatus  
according to claim 1, wherein said correction means

computes a first average weighting value on the image pickup screen of said capture means using the position of the feature point obtained by said prediction means, and a second average weighting value on the image pickup screen of said capture means of the feature point detected by said detection means, and corrects the parameter such that the first average weighting value matches the second average weighting value.

10 15. The position and orientation determination apparatus according to claim 13, wherein when said parameter of said capture means is processed plural times alternately by rotation transform and translation transform, said correction means repeats the process until an average value or a average weighting value of an error between the position of the feature point corrected by said prediction means and the position of the feature point on the image pickup screen can be considerably small or until the error cannot be smaller.

20 16. The position and orientation determination apparatus according to claim 14, wherein when said parameter of said capture means is processed plural times alternately by rotation transform and translation transform, said correction means repeats the process until an average value or a average weighting value of an error between the position of the feature point corrected by said prediction

means and the position of the feature point on the image pickup screen can be considerably small or until the error cannot be smaller.

5 17. The position and orientation determination apparatus according to claim 13, wherein when said correction means corrects the parameter such that said capture means can rotate, the feature point whose position predicted by said prediction means is associated with the feature point  
10 detected by said detection means, a rotation axis and a rotation angle with which the position of the feature point on the image pickup screen of said capture means using the position of the feature point obtained by said prediction means matches the position of the feature point on the image  
15 pickup screen of said capture means obtained by said detection means are obtained for each feature point, and said parameter can be corrected by using average values of the rotation axis and the rotation angle obtained for each feature point which is dealt with.

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18. The position and orientation determination apparatus according to claim 14, wherein when said correction means corrects the parameter such that said capture means can rotate, the feature point whose position predicted by said  
25 prediction means is associated with the feature point detected by said detection means, a rotation axis and a rotation angle with which the position of the feature point

on the image pickup screen of the capture means using the position of the feature point obtained by said prediction means matches the position of the feature point on the image pickup screen of said capture means obtained by said

5 detection means are obtained for each feature point which is dealt with, and said parameter can be corrected using average weighting values of the rotation axis and the rotation angle obtained for each feature point which is dealt with.

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19. The position and orientation determination apparatus according to claim 13, wherein when said correction means corrects the parameter such that said capture means can translate, the feature point whose position predicted by  
15 said prediction means is associated with the feature point detected by said detection means, a difference between the position of the feature point obtained by said prediction means and the position of the feature point obtained by said detection means is obtained for each feature point which  
20 is dealt with, and said parameter can be corrected using average values of the difference obtained for each feature point which is dealt with.

20. The position and orientation determination apparatus  
25 according to claim 14, wherein when said correction means corrects the parameter such that said capture means can translate, the feature point whose position predicted by

said prediction means is associated with the feature point detected by said detection means, a difference between the position of the feature point obtained by said prediction means and the position of the feature point obtained by said  
5 detection means is obtained for each feature point which is dealt with, and said parameter can be corrected using average weighting values of the difference obtained for each feature point which is dealt with.

10 21. A position and orientation determining method which identifies a parameter indicating a position and orientation of capture means for capturing an picture in real space containing a plurality of feature points whose positions are known in a three-dimensional array,  
15 comprising:

a position and orientation measuring step of measuring the position and orientation of the capture means in a method other than using a captured picture;

a detecting step of detecting the plurality of feature  
20 points and their positions in a two-dimensional array on an image pickup screen using the picture in the real space captured by said capture means;

a predicting step of predicting the positions of the feature points in the two-dimensional array on the image  
25 pickup screen based on the position and orientation of said capture means measured in said position and orientation measuring step; and



a correcting step of correcting the parameter  
indicating the position and orientation of said capture  
means based on the positions of the feature points on the  
image pickup screen of said capture means obtained in said  
5 predicting step, and based on the positions of the feature  
points obtained in said detecting step,

wherein said parameter indicating the position and  
orientation of said capture means for capturing the real  
space is identified by correcting the parameter in said  
10 correcting step.

22. The program code which performs the position and  
orientation determining method according to claim 21.

15 23. The storage medium storing the program code according  
to claim 22.